CHAPTER 2

PFPR Operations

This chapter describes seven types of basic operations, shown in Table 2-1, used in the PFPR industry. The descriptions presented are simplified and will be most useful for those readers unfamiliar with the industry. They are intended to be used in conjunction with the P2 glossary located in Chapter 3 to help identify and implement specific P2 opportunities.

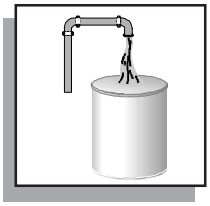
Facilities in the PFPR industry formulate, package, and repackage a variety of pesticide products, including herbicides, insecticides, and fungicides. These facilities typically have physical divisions between formulating and packaging operations, and between dry and liquid operations.

Table 2-1
PFPR Operations

- Liquid Formulating
- Dry Formulating
- Liquid Packaging
- Dry Packaging
- Aerosol Packaging
- Pressurized Gas Formulating and Packaging
- Repackaging

Because of the large number of pesticide products a facility may handle, most PFPR facilities operate on the principle of "just-in-time" production. This principle basically dictates that products are made on customer demand to reduce the space needed to keep large inventories on hand. However, because production is tied to customer orders, the specific products that are formulated, packaged, or repackaged can vary from day to day and hour to hour. Therefore, facilities often use an equipment line (e.g., a liquid formulating line) to make multiple products over the course of a day, or week, or month.

Facilities typically formulate, package, or repackage these products in batches. They also usually have the flexibility to "mix and match" equipment as needed. For example, a facility may have two formulation mix tanks, Tank A with a capacity of 100 gallons and Tank B with a capacity if 500 gallons. Both mix tanks have piping connections to a product storage tank (Tank C) with a capacity of 500 gallons. The facility can configure these tanks two ways, depending on the amount of product to be formulated. If 100 gallons of product or less are scheduled to be made, the facility connects Tank A with Tank C and uses Tank A to formulate the product. If more than 100 gallons of product are scheduled to be made, the facility connects Tank B with Tank C and uses Tank B to formulate the product. In both cases, the facility is attempting to maximize their production while minimizing the amount of equipment that will need to be cleaned prior to formulating a new product.



Liquid Formulating

Liquid formulations contain mixtures of several raw materials, including pesticide active ingredients, inert ingredients, and a base solvent, and may also contain emulsifiers or surfactants. The solvent may be water or an organic chemical, such as isopropyl alcohol or petroleum distillate. In some cases, the formulation is an emulsion and contains both water and an organic solvent. Solid materials, such as powders or granules, may also be used as part of a liquid formulation by being dissolved or emulsified in the solvent to form a liquid or suspension. The formulated product may be in a concentrated form requiring dilution before application, or may be ready to apply.

An example of a liquid-based formulating line is shown in Figure 2-1. Typical liquid formulating lines consist of storage tanks or containers to hold active and inert raw materials, and a mixing tank for formulating the pesticide product. A storage tank may also be used on the formulating line to hold the formulated pesticide product, prior to a packaging step. Facilities may receive their raw materials in bulk and store them in bulk storage tanks, or they may receive the raw materials in smaller quantities, such as 55-gallon drums, 50-pound bags, or 250-gallon minibulk containers or "totes" (smaller, refillable containers). These raw materials are either piped to the formulation vessel from bulk storage tanks, or added directly to the vessel from drums, bags, or minibulks. Typically, water or the base solvent is added to the formulation vessel in bulk quantities.

The formulating line may also include piping and pumps for moving the raw material from the storage tanks to the mixing tank, and for moving formulated pesticide product to the packaging line. Other items that may be part of the line are premixing tanks, stirrers, heaters, bottle washers, and air pollution control equipment. Some lines may also contain refrigeration units for formulation, storage units, scales, and other equipment.

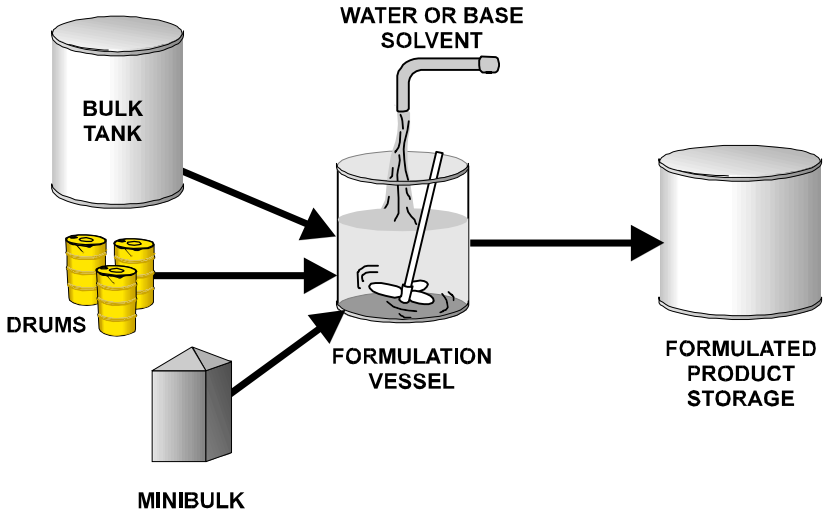
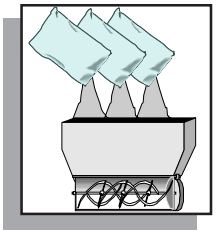


Figure 2-1. Liquid-Based Formulation Line



Dry Formulating

Dry formulations contain active and inert ingredients; the final product may be in many different forms, such as powders, dusts, granules, blocks, solid objects impregnated with pesticide (e.g., flea collars), pesticides formed into a solid shape (e.g., pressed tablets), or microencapsulated dusts or granules. They are formulated in various ways, including mixing powdered or granular actives with dry inert carriers, spraying or mixing a liquid active ingredient onto a dry carrier, soaking or using pressure and heat to force active ingredients into a solid matrix, mixing active ingredients with a monomer and allowing the mixture to polymerize into a solid, and drying or hardening an active ingredient solution into a solid form. These dry pesticide products may be designed for application in solid form or to be dissolved or emulsified in water or solvent prior to application.

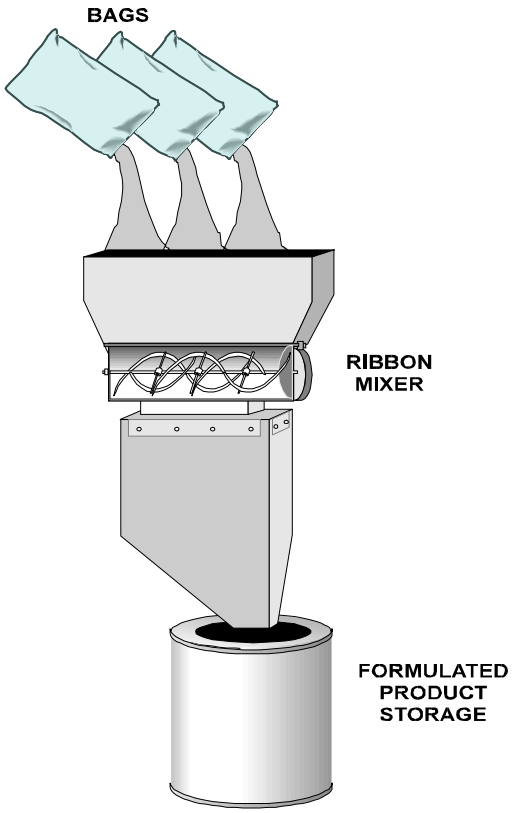


Figure 2-2. Granular Formulation Line

Because of the many types of dry pesticide products, dry pesticide formulating lines can vary considerably. Figures 2-2 and 2-3 are examples of granular and dry spray-coated formulation lines. Dry formulating lines typically have tanks or containers to hold the active ingredients and inert raw materials, and may include mixing tanks, ribbon blenders, extruding equipment, high-pressure and temperature tanks for impregnating solids with active ingredient, a vacuum or other type of drying equipment, tanks or bins for storage of the formulated pesticide product, pelletizers, presses, milling equipment, sieves, and sifters.

Raw materials for dry pesticide products may be liquid or solid. Liquid raw materials may be stored in rail tank cars, tank trucks, minibulks, drums, or bottles. Dry raw materials may be stored in silos, rail cars, tank trucks, minibulks, supersacks, metal drums, fiber drums, bags, or boxes. Liquid raw materials may be pumped, poured, or sprayed into formulation vessels, while dry raw materials are frequently transferred to formulation equipment by screw conveyors (consisting of a helix mounted on a shaft and turning in a trough), through elevators, or by pouring.

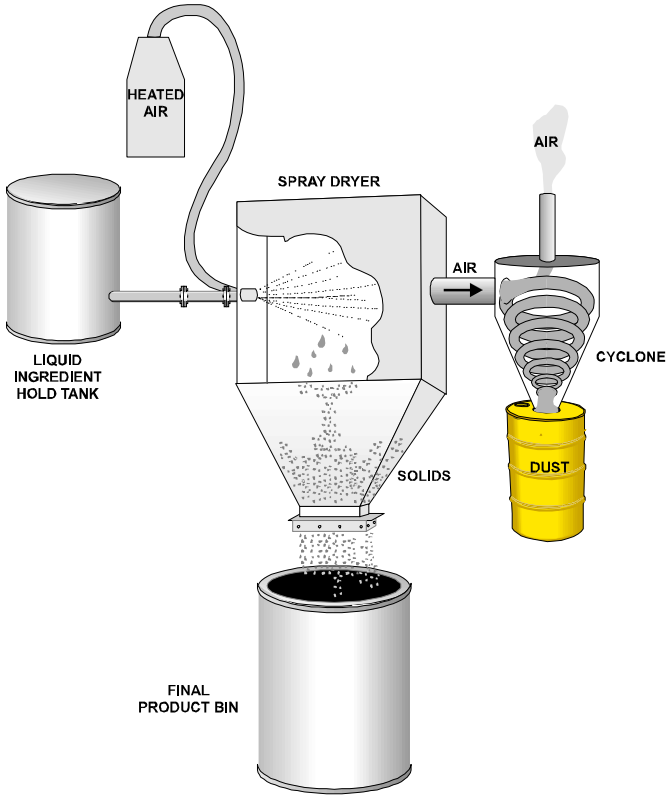


Figure 2-3. Dry Spray-Coated Formulation Line

Dry formulating lines may also include piping and pumps for moving raw materials from storage tanks to the formulation equipment, and for moving formulated pesticide product to the packaging equipment. Other items that may be included in the dry pesticide formulating line are premixing tanks, tanks for storing formulated product prior to packaging, stirrers, heaters, refrigeration units on formulation and storage equipment, scales, and air pollution control equipment (e.g., cyclones, filters, or baghouses). Dry pesticide products may be packaged into rail tank cars, tank trucks, totes, minibulks, and water-soluble packaging, but are typically packaged into bags, boxes, or drums.

Liquid Packaging

Many liquid formulations are packaged by simply transferring the final product into containers. Figure 2-4 depicts a liquid packaging line. Small quantities of product are often manually packaged by gravity feeding the product directly from the formulation tank into the product container. For larger quantities, the process is often automated. Formulated product is transferred to the packaging line through pipes or hoses, or is received from a separate formulating facility, and placed in a filler tank. A conveyor belt is used to carry product containers, such as jugs, bottles, cans, or drums, through the filling unit, where nozzles dispense the appropriate volume of product. The belt then carries the containers to a capper, which may be automated or manual, and then to a labeling unit. Finally, the containers are packed into shipping cases.

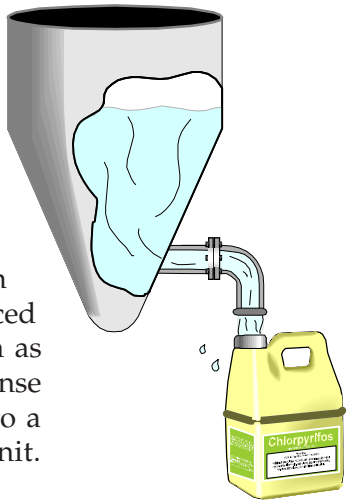
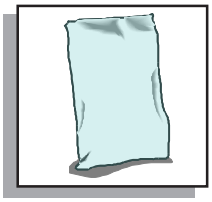


Figure 2-4. Liquid Packaging Line



Dry Packaging

Dry formulations are also packaged by simply transferring the final product into boxes, drums, jugs, or bags. Figure 2-5 depicts a dry packaging line. Again, small quantities or bags are typically packaged manually using a gravity feed to carry the product from the formulating unit into the containers or bags. Larger quantities may be packaged on an automated line, similar to liquid packaging lines.

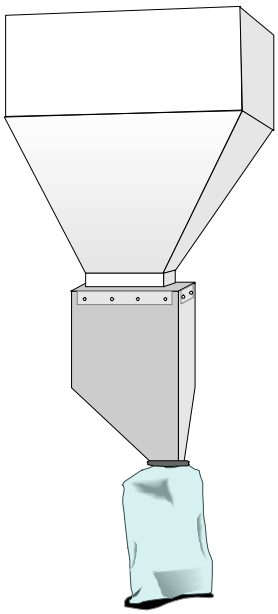


Figure 2-5. Dry Packaging Line

Aerosol Packaging

Some water- or solvent-based liquid pesticide products are packaged as aerosols. Figure 2-6 is an example of an aerosol packaging line. The product is placed in spray cans that are put under pressure, and a propellant is added. When the end user sprays the aerosol, the propellent forces the product out of the can and allows the product to be applied to surfaces or to be dispersed in the air. An aerosol packaging line typically includes a filler, a capper, a propellant injector, and a U.S. Department of Transportation (DOT) test bath. In the filler, formulated pesticide product is dispensed into empty aerosol cans, in much the same way that the liquid packaging lines fill containers. The cans are then sent to the capper, where a cap with nozzle is placed on the can. The can enters a separate room, where the propellent is injected into the can, a vacuum is pulled, and the cap is crimped to make the can airtight. In order to comply with DOT regulations on the transport of pressurized containers, each can must then be tested for leaks and rupturing in a DOT test bath. The DOT test bath is a 130°F hot water bath into which cans are submerged and observed for leaks or ruptures. The aerosol packaging line may also include a can washer to remove residue from can exteriors prior to entering the test bath (to reduce contaminant buildup in the bath), a dryer to dry can exteriors, and machinery to package aerosol cans into boxes for shipment.

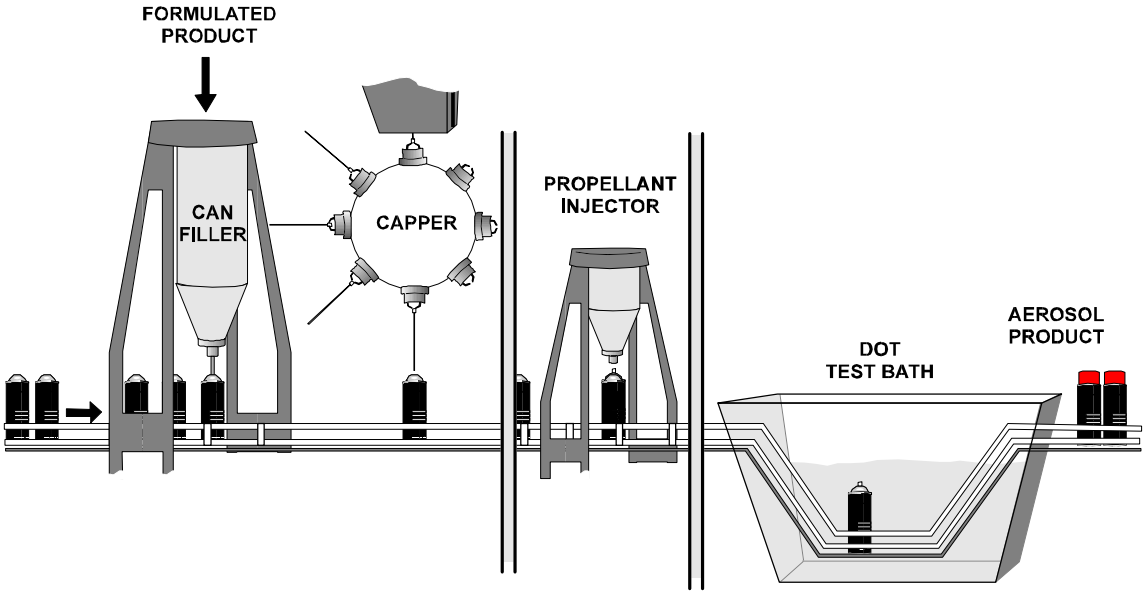
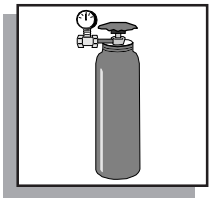


Figure 2-6. Aerosol Packaging Line



Pressurized Gas Formulating and Packaging

Some pesticide products are formulated and packaged as pressurized gases. Figure 2-7 depicts a pressurized gas production line. The active and inert ingredients are received as liquids, pressurized liquids, or gases, and are stored in tanks, tank trucks, rail cars, or minibulk storage containers. Liquid ingredients are placed in a holding tank prior to formulation. Formulating and packaging operations for these products typically occur in one

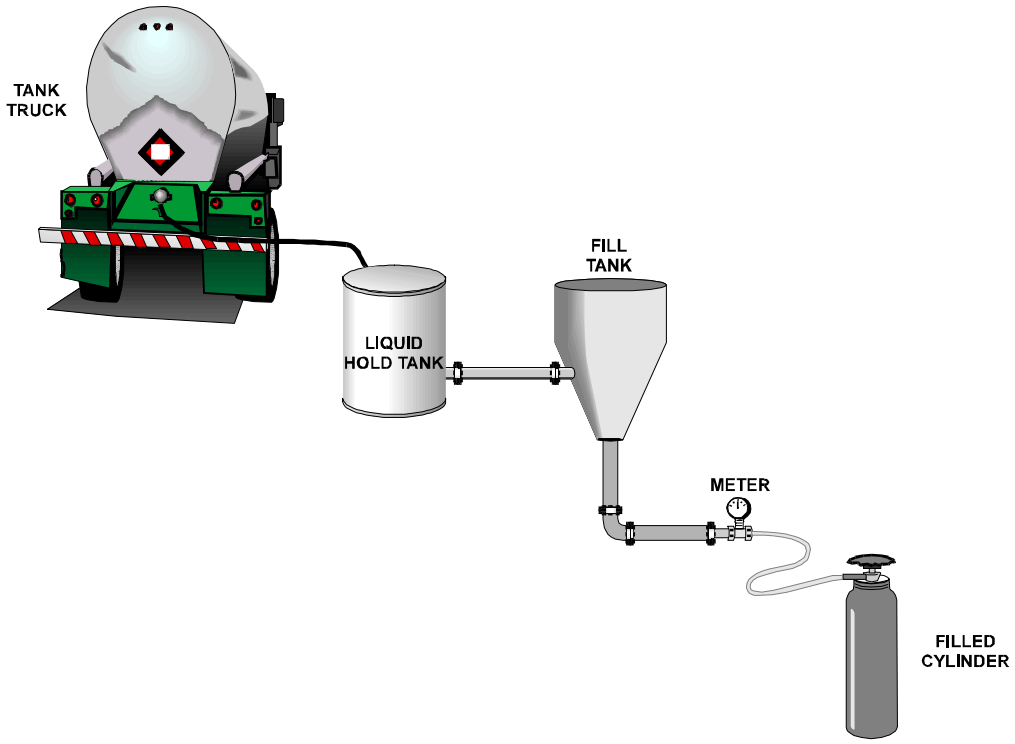
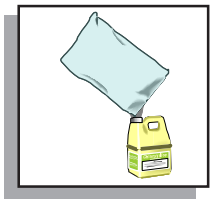


Figure 2-7. Pressurized Gas Formulating and Packaging Line

step in a closed-loop system. The ingredients are metered by weight through pressurized transfer lines into DOT-approved steel application cylinders. Other equipment that may be included in a pressurized gas line includes pumps, piping, and heating and refrigerating units to maintain gas pressures and temperatures in storage.

The cylinders may be refilled at a later date, after they have been tested to ensure that they are still capable of containing pressurized fluids. DOT requires hydrostatic pressure testing, as well as visual examination of the cylinder. Hydrostatic pressure testing involves filling the tank with water to a specified pressure and volume. If more water can be held in the cylinder than its original volume, or if the cylinder weighs less than 10% of its original weight, it is possible the cylinder walls are deformed, and the cylinder fails the test. Visual inspection entails purging the cylinder of its vapors using an inert gas such as nitrogen, and inspecting the inside for pitting and other defects with a fiber optic probe. The cylinder is then rinsed with water and dried.



Repackaging

Repackaging operations are similar to packaging operations, except the "raw material" is an already formulated product that has been packaged for sale. Repackagers often purchase formulated pesticide products, transfer the product to new containers with customer-specific labeling, and sell them to distributors.

A separate type of repackaging, called refilling, is usually performed by agrichemical facilities that transfer pesticide products from bulk storage tanks into minibulks. These refillable containers are constructed of plastic and typically have capacities ranging from 100 to 500 gallons. Minibulks may be owned by the refilling establishment, the pesticide registrant, or by the end user. Production lines usually consist of a bulk storage tank, a minibulk tank into which the product is repackaged, and any interconnecting hoses or piping. The bulk storage tanks are usually dedicated by product and clustered together in a diked area. The products are dispensed to the minibulks either manually or by using a computer-regulated system of pumps and meters. The minibulks are typically reused by farmers or custom applicators and returned to the refilling establishment.